Innovative, Low-cost Phased Microphone Array Design for Moderate-Scale Aeroacoustics Tests

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The objective of this study is to develop, build, and test prototypes of a novel acoustic level sensor for use in closed or open test section wind tunnel for aeroacoustic investigations of moderate-to large-scale quiet, next-generation aircraft configurations. A new microphone array with 24 sensors in a 32" diameter pattern was designed for accurate sound-level measurements from 100Hz to 30,000 Hz appropriate for test articles ranging from 1/6- to full-scale. The new array design was optimized for accurate level measurement with optimal background noise suppression rather than high spatial resolutions, resulting in smaller array size, lower sensor count and cost relative to larger source location arrays. Two new arrays were designed and built for wall-mounted operation in the AEDC NFAC 40- by 80-Ft Wind Tunnel, but the modular designs can be adapted to other open- and closed test-section tunnels currently used in aeroacoustics research. Two configurations were studied: one with microphones mounted on a plate flush with the wind tunnel wall, and one with the microphone plate recessed ½" behind a porous Kevlar wind screen shown to significantly reduce boundary layer noise. The two arrays were recently calibrated in an anechoic chamber, then tested over a range of speeds up to 300 kts in the wind tunnel. Preliminary results show that advanced array processing methods such as background noise subtraction combined with the passive background suppression of the Kevlar screen can reduce the background noise contamination by more than 22 dB over most of the design frequency range relative to a single in-flow microphone.

The demonstration/calibration test for the seedling study followed a full-scale demonstration of a Boeing 757 rudder with new active flow control by the NASA Environmentally Responsible Aviation (ERA) project. Since the array design had been completed prior to this test, the NASA Fundamental Aerodynamics Fixed Wing Program funded the building of four additional arrays and test operations to acquire the first acoustic measurements of the sweeping jet actuator active rudder concept during this test. Analysis of this data is in progress, and will help estimate community noise impact of a flight test of the active rudder concept.